Geophysical Research Abstracts
Vol. 17, EGU2015-13203-1, 2015
EGU General Assembly 2015

Characterisation of microhabitat quality of different biochars

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Biochar is considered a promising means both to improve soil fertility and sequester carbon from the atmosphere. The former is being achieved by improving soil physico-chemical properties as microhabitat provision and thereby favorably impacting soil community structure and functions. However, contradicting results have been found regarding biochars' direct impact on soil microbial communities, indicating great specificity of every biochar and great heterogeneity within defined biochar samples in terms of physico-chemical properties influencing microbial colonisation. Habitable pore space, C content and degree of condensation and functionality and charge of surfaces are considered important parameters determining whether a piece of biochar is subject to autochthonous colonisation processes or not.

Of these, the systematic investigation of habitable pore space is of crucial importance for the understanding of microbial colonisation potential. For example, larger pores are more prone to dehydration whilst smaller pores exhibit a higher water retention against drainage but may be less colonisable by (micro-)organisms due to size limitations. Biochar reflects plant anatomic structure and macro- and mesopores originate from tracheal and tracheid tissue well connected by perforations for the purpose of symplastic pressure release at high water potentials. These remain unchanged by the pyrolitic process. Nanopores, however, are the result of condensation induced crack formation and can be regarded as locally single and sparsely connected events. Furthermore anatomic structures differ between plant families and are considered to be most evident in the comparison between grass-derived and wood-derived biochars.

Biochars derived from wood and Miscanthus are investigated after 3 years of aging under outdoor conditions with respect to microorganisms present on the char surface. Biochar pieces are resin impregnated and subjected to μ-CT scanning. μ-CT is a very promising method for the non-invasive 3D investigation of highly opaque materials such as biochar or soil samples, allowing for the location and quantification of internal and exposed pore space available and distribution of pore sizes within blocks of biochar. As biochar is a highly heterogeneous material, μ-CT offers the possibility of investigating and quantifying microbial habitat heterogeneity within small batches of believed highly defined chars, enabling the researcher to make estimations on the overall validity of results, thus avoiding the overestimation of possibly contradicting results for the behaviour of small and very specific batches of biochar. Most importantly 3D models of biochar blocks can be analysed for pore connectivity which allows for the prediction of hyraulic behaviour under different water potentials. Resin impregnated blocks are subsequently analysed for the presence of microorganisms applying in-situ hybridisation and fluorescence microscopy.

A detailed description of physical properties and hydraulic behaviour of specific biochars as habitat for soil microorganisms is key for the understanding of how biochars act as soil amendment meant to enhance soil fertility.